Section 7.2

Check Your Understanding, page 445:

1. The mean of the sampling distribution of $\hat{p}$ is equal to the population proportion. In this case $\mu_{\hat{p}} = p = 0.75$.

2. The standard deviation of the sampling distribution of $\hat{p}$ is
$\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.75(0.25)}{1000}} = 0.0137$. There are more than 10(1000) = 10,000 young adult Internet users, so the 10% condition has been met.

3. The sampling distribution of $\hat{p}$ is approximately Normal. Both $np = 1000(0.75) = 750$ and $n(1-p) = 1000(0.25) = 250$ are at least 10.

4. If the sample size were 9000 instead of 1000, the sampling distribution would still be approximately Normal with mean 0.75. However, the standard deviation of the sampling distribution would be smaller by a factor of 3. In this case,
$\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.75(0.25)}{9000}} = 0.0046$.

Exercises, page 447:

7.27 (a) We would not be surprised to find 8 (32%) orange candies. From the graph in Figure 7.11 there were a fair number of samples in which there were 8 or fewer orange candies. On the other hand, there were only a couple of samples in which there were 5 (20%) or fewer orange candies. So, if we got only 5 orange candies, we should be surprised.
(b) It is more surprising to get 32% orange candies in a sample of 50 than it is in a sample of 25. Comparing the graphs in figures 7.11 and 7.12, there were a fair number of simulations in 7.11 (sample size 25) with 32% or less, but very few in 7.12 (sample size 50) with 32% or less.

7.28 (a) We would be surprised to find 32% orange candies in this case. Very few of the samples of size 25 had 32% or more orange candies. However, we would not be surprised to find 20% orange candies. 20% is very near the center of the distribution and not unusual at all.
(b) We would be surprised to find 32% orange candies in either case since neither simulation had many samples with 32% or more orange candies. However, it would be even more surprising when the sample size is 50 because there were fewer samples of size 50 that had at least 32% orange candies than samples of size 25.

7.29 (a) The mean of the sampling distribution is equal to the population proportion, so $\mu_{\hat{p}} = p = 0.45$.
(b) The standard deviation of the sampling distribution is
$\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.45(0.55)}{25}} = 0.0995$. The 10% condition is met because it is very likely true that there are more than 10(25) = 250 candies in the large machine.
(c) The sampling distribution is approximately Normal because $np = 25(0.45) = 11.25$ and $n(1-p) = 25(0.55) = 13.75$ are both at least 10.

(d) If the sample size were 100 rather than 25, the sampling distribution would still be approximately Normal with a mean of $\mu_{\hat{p}}$ = 0.45. However, the standard deviation decreases to

$$\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.45(0.55)}{100}} = 0.0497.$$

7.30 (a) The mean of the sampling distribution is equal to the population proportion, so $\mu_{\hat{p}} = p = 0.15$.

(b) The standard deviation of the sampling distribution is

$\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.15(0.85)}{25}} = 0.0714$. In this case, the 10% condition is met because it is very likely true that there are more than 10(25) = 250 candies in the large machine.

(c) The sampling distribution is not approximately Normal because $np = 25(0.15) = 3.75$ is less than 10. Note that $n(1-p) = 25(0.85) = 21.25$ is at least 10, but the Large Counts conditions requires that both numbers must be at least 10.

(d) If the sample size were 225 rather than 25, the sampling distribution would now be approximately Normal because $np = 225(0.15) = 33.75$ and $n(1-p) = 225(0.85) = 191.25$ are both at least 10. The mean is still $\mu_{\hat{p}}$ = 0.15, but the standard deviation decreases to

$$\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.15(0.85)}{225}} = 0.0238.$$

7.31 (a) No. The 10% condition is not met here because more than 10% of the population (10/76 = 13%) was selected.

(b) No. The Large Counts condition is also not met because the sample size was only n = 10. Neither np nor $n(1-p)$ will be at least 10.

7.32 (a) Yes. The 10% condition is met here because less than 10% of the population (7/100 = 7%) was selected.

(b) The Large Counts condition is not met here because the sample size was only n = 7. Neither np nor $n(1-p)$ will be at least 10.

7.33 The Large Counts condition is not met because $np = 15(0.3) = 4.5 < 10$.

7.34 The 10% condition is not met because more than 10% of the population (50/316 = 15.8%) was selected.

7.35 (a) The mean of the sampling distribution of $\hat{p}$ is equal to the population proportion. In this case, $\mu_{\hat{p}} = p =$ 0.70.

(b) The standard deviation of the sampling distribution of $\hat{p}$ is

$\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}} = \sqrt{\frac{0.7(0.3)}{1012}} = 0.0144$. The 10% condition is met because the sample of size 1012 is less than 10% of the population of all U.S. adults.

(c) The sampling distribution of $\hat{p}$ is approximately Normal because $np = 1012(0.70) = 708.4$ and $n(1-p) = 1012(0.30) = 303.6$ are both at least 10.

(d) **Step 1: State the distribution and values of interest.** $\hat{p}$ has an approximately Normal distribution with mean 0.70 and standard deviation 0.0144. We want to find $P(\hat{p} \le 0.67)$. **Step 2: Perform calculations. Show your work.** The standardized score for the boundary value is $z = \frac{0.67 - 0.70}{0.0144} = -2.08$. The desired probability is $P(Z \le -2.08) = 0.0188$. *Using technology*: normalcdf(lower: –1000, upper: 0.67, μ : 0.70, σ : 0.0144) = 0.0186. **Step 3: Answer the question.** There is a 0.0186 probability of obtaining a sample in which 67% or fewer say they drink the milk. Because this is a small probability, there is convincing evidence against the claim—it isn't plausible to get a sample proportion this small by chance alone.

7.36 (a) The mean of the sampling distribution of $\hat{p}$ is equal to the population proportion. In this case, $\mu_{\hat{p}} = p = 0.4$.

(b) The standard deviation of the sampling distribution of $\hat{p}$ is $\sigma_{\hat{p}} = \sqrt{\frac{0.4(0.6)}{1785}} = 0.0116$. The 10% condition is met because the sample of size 1785 is less than 10% of the population of adults.

(c) The sampling distribution of $\hat{p}$ is approximately Normal because $np = 1785(0.4) = 714$ and $n(1-p) = 1785(0.6) = 1071$ are both at least 10.

(d) **Step 1: State the distribution and values of interest.** $\hat{p}$ has an approximately Normal distribution with mean 0.40 and standard deviation 0.0116. We want to find $P(\hat{p} \ge 0.44)$. **Step 2: Perform calculations. Show your work.** The standardized score for the boundary value is $z = \frac{0.44 - 0.40}{0.0116} = 3.45$. The desired probability is $P(Z \ge 3.45) = 1 - 0.9997 = 0.0003$. *Using technology*: normalcdf(lower: 0.44, upper: 1000, μ : 0.40, σ : 0.0116) = 0.0003. **Step 3: Answer the question.** There is a 0.0003 probability of obtaining a sample in which 44% or more say they attended church last week. Because this is a small probability, there is convincing evidence against the claim—it isn't plausible to get a sample proportion this large by chance alone.

7.37 Because the standard deviation is found by dividing by $\sqrt{n}$, using $4n$ for the sample size halves the standard deviation $\left(\sqrt{4n} = 2\sqrt{n}\right)$; we would need to sample $1012(4) = 4048$ adults.

7.38 Because the standard deviation is found by dividing by $\sqrt{n}$, using $9n$ for the sample size reduces the standard deviation of the sampling distribution to one-third of the previous value $\left(\sqrt{9n} = 3\sqrt{n}\right)$; we would need to sample $9(1785) = 16{,}065$ adults.

7.39 **Step 1: State the distribution and values of interest.** We have an SRS of size 267 drawn from a population in which the proportion $p = 0.70$ of college women have been on a diet within the past 12 months. Thus, $\mu_{\hat{p}} = 0.70$. Because 267 is less than 10% of the population of college women, $\sigma_{\hat{p}} = \sqrt{\frac{0.7(0.3)}{267}} = 0.0280$. Because $np = 267(0.7) = 186.9$ and $n(1-p) = 267(0.3) = 80.1$ are both at least 10, the sampling distribution of $\hat{p}$ can be approximated by a Normal distribution. We want to find $P(\hat{p} \geq 0.75)$ using the *N*(0.70, 0.0280) distribution. **Step 2: Perform calculations. Show your work.** The standardized score for the boundary value is $z = \frac{0.75 - 0.7}{0.0280} = 1.79$. The desired probability is $P(Z \geq 1.79) = 1 - 0.9633 = 0.0367$. *Using technology*: normalcdf (lower: 0.75, upper: 1000, μ: 0.7, σ: 0.0280) = 0.0371. **Step 3: Answer the question.** There is a 0.0371 probability that 75% or more of the women in the sample have been on a diet within the last 12 months.

7.40 **Step 1: State the distribution and values of interest.** We have an SRS of size 500 drawn from a population in which the proportion $p = 0.14$ of registered motorcycles are Harley-Davidsons. Thus, $\mu_{\hat{p}} = 0.14$. Because 500 is less than 10% of the population of registered motorcyles, $\sigma_{\hat{p}} = \sqrt{\frac{0.14(0.86)}{500}} = 0.0155$. Because $np = 500(0.14) = 70$ and $n(1-p) = 500(0.86) = 430$ are both at least 10, the sampling distribution of $\hat{p}$ can be approximated by a Normal distribution. We want to find $P(\hat{p} \geq 0.20)$ using the *N*(0.14, 0.0155) distribution. **Step 2: Perform calculations. Show your work.** The standardized score for the boundary value is $z = \frac{0.20 - 0.14}{0.0155} = 3.87$. The desired probability is $P(Z \geq 3.87) \approx 0$. *Using technology*: normalcdf (lower: 0.20, upper: 1000, μ: 0.14, σ: 0.0155) = 0.0001. **Step 3: Answer the question.** There is a 0.0001 probability that 20% or more of the motorcycles in the sample are Harleys.

7.41 (a) **Step 1: State the distribution and values of interest.** We have an SRS of size 100 drawn from a population in which the proportion $p = 0.90$ of orders are shipped within three working days. Thus, $\mu_{\hat{p}} = 0.90$. Because 100 is less than 10% of the population of orders (100/5000 = 2%), $\sigma_{\hat{p}} = \sqrt{\frac{0.90(0.10)}{100}} = 0.03$. Because $np = 100(0.90) = 90$ and $n(1-p) = 100(0.10) = 10$ are both at least 10, the sampling distribution of $\hat{p}$ can be approximated by a Normal distribution. We want to find $P(\hat{p} \leq 0.86)$ using the *N*(0.90, 0.03) distribution. **Step 2: Perform calculations. Show your work.** The standardized score for the boundary value is $z = \frac{0.86 - 0.90}{0.03} = -1.33$. The desired probability is $P(Z \leq -1.33) = 0.0918$. *Using technology*: normalcdf (lower: –1000, upper: 0.86, μ: 0.90, σ: 0.03) = 0.0912. **Step 3: Answer the question.** There is a 0.0912 probability that 86% or fewer of orders in an SRS of 100 were shipped within 3 working days.

(b) It isn't unusual to get a sample proportion of 0.86 or smaller when selecting an SRS of 100 from a population in which p = 0.90. Thus, it is plausible that the 90% claim is correct and that the lower than expected percentage is due to chance alone.

7.42 (a) **Step 1: State the distribution and values of interest.** We have an SRS of size 100 drawn from a population in which the proportion p = 0.67 of college students support a crackdown on underage drinking. Thus, $\mu_{\hat{p}} = 0.67$. Because 100 is less than 10% of the population of students at a large college, $\sigma_{\hat{p}} = \sqrt{\frac{0.67(0.33)}{100}} = 0.0470$. Because $np = 100(0.67) = 67$ and $n(1-p) = 100(0.33) = 33$ are both at least 10, the sampling distribution of $\hat{p}$ can be approximated by a Normal distribution. We want to find $P(\hat{p} \le 0.62)$ using the N(0.67, 0.0470) distribution. **Step 2: Perform calculations. Show your work.** The standardized score for the boundary value is $z = \frac{0.62 - 0.67}{0.0470} = -1.06$. The desired probability is $P(Z \le -1.06) = 0.1446$. *Using technology*: normalcdf (lower: –1000, upper: 0.62, μ : 0.67, σ : 0.0470) = 0.1437. **Step 3: Answer the question.** There is a 0.1437 probability that 62% or fewer students in an SRS of 100 support a crackdown on underage drinking.
(b) It isn't unusual to get a sample proportion of 0.62 or smaller when selecting an SRS of 100 from a population where p = 0.67. Thus, it is plausible that the 67% claim is correct and that the lower than expected percentage is due to chance alone.

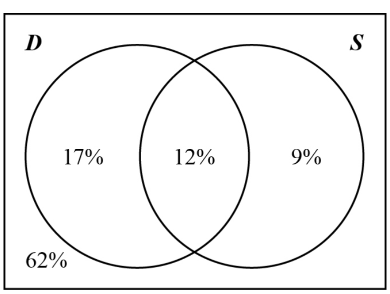
7.43 a.

7.44 b.

7.45 b.

7.46 b.

7.47 The Venn diagram is shown below.



62% neither download nor share music files.

7.48 (a) Assign numbers 01-14 to the animals (01 to the desert tortoise, 02 to the Olive Ridley sea turtle,…, 14 to the San Francisco garter snake). Starting at line 111 in Table D, read pairs of numbers until you get three different numbers between 01 and 14. These numbers represent the animals chosen. (b) Using line 111 in Table D, the animals chosen are 12, 04, and 11, which represent the blunt-nosed leopard lizard, the flat-tailed horned lizard and the Coachella Valley fringe-toed lizard.